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## EUROPEAN PATENT APPLICATION

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AT BE CH DE DK ES FR GB GR IT LI LU NL SE⑳ Applicant : YEDA RESEARCH AND  
DEVELOPMENT COMPANY LIMITED  
P.O. Box 95  
Rehovot 76100 (IL)㉑ Inventor : Shenkar, Victor  
5 Renanim Street  
Ramat Gan, Israel 52595 (IL)  
Inventor : Naaman, Ron  
14 Tel Aviv Street  
Ness Ziona (IL)  
Inventor : Vager, Zeev c/o The Weizmann  
Institut of Science  
Neve Metz 18  
Rehovot, Israel 76100 (IL)㉒ Representative : Smith, Norman Ian et al  
F.J. CLEVELAND & COMPANY 40-43 Chancery  
Lane  
London WC2A 1JQ (GB)

DOC

㉔ Flat panel display device.

㉕ A flat panel display device includes a backplate (4) and a transparent front face (6) delimiting an hermetically sealed vacuum space and an array (9) of selectively actuatable electron-emitting cold cathodes disposed adjacent to, or on the backplate. A stratum (16) including an electron-multiplier (18) is placed in close proximity to the array of cold cathodes. The device also includes a luminescing surface (22) capable of emitting light upon being impinged upon by a pulse of electron beam emerging from the electronic multiplier. One embodiment includes an electron multiplier having an amorphous structure and cold cathodes of the metal-insulator-metal tunnelling type.

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## FIELD OF THE INVENTION

The present invention relates to flat panel display devices, and more particularly to flat panel devices utilizing selectively actuatable cold cathode or electron-tunnel junctions for activating electron-multiplier means, which in turn activate a luminescing screen.

## BACKGROUND OF THE INVENTION

Flat panel displays have been proposed in the past. For example, U.S. Patent 3,500,102 discloses two superposed substrates of dielectric material respectively supporting a first and a second group of intersecting spaced-apart conductors, a plurality of openings made in one of said substrates, each opening extending through the distance between said conductors and each opening housing a semiconductor which is in contact with both conductors. When a potential difference is applied between conductors, bracketing an opening, electrons are emitted from the semiconductor to be accelerated towards a screen.

The U.S. Patent 4,857,799 discloses a matrix-addressed, flat panel display having a matrix array of cathodes. Each of the cathodes consists of an array of field emitter tips projecting from the face of a substrate on which they are mounted. Adjacent the tips, there are positioned electrically conductive gates in order to generate and to control electron emission from the tips.

In the co-pending U.S. Application Serial No. 07/385,022 in the names of Z. Vager and R. Naaman and assigned to the same Applicant, there is described a multi-layer arrangement of partially conductive material consisting of packed particles, for use as an electron multiplier.

It is one of the broad objects of the present invention to utilize the advantages of the improved electron multiplier of the above-mentioned co-pending application and to provide a flat panel display device employing same.

It is a further broad object of the invention to provide a flat panel display device employing selectively actuatable cold cathodes or electron-emitting junctions as sources of electron emission activators for electron-multipliers of any suitable type.

## SUMMARY OF THE INVENTION

In accordance with the present invention there is therefore provided a flat panel display device, comprising a backplate and a transparent front face delimiting an hermetically sealed vacuum space; an array of selectively actuatable electron-emitting cold cathodes disposed adjacent to, or on said backplate; a stratum including electron-multiplier means placed in, at least, close proximity to said array of cold cathodes; and a luminescing surface capable of emit-

ting light upon being impinged upon by a pulse of electron beam emerging from said electron multiplier means.

The invention will now be described in connection with certain preferred embodiments, with reference to the following illustrative figures so that it may be more fully understood.

With specific reference now to the figures in detail, it is stressed that the particulars shown are by way of example and for purposes of illustrative discussion of the preferred embodiments of the present invention only and are presented in the cause of providing what is believed to be the most useful and readily understood description of the principles and conceptual aspects of the invention. In this regard, no attempt is made to show structural details of the invention in more detail than is necessary for a fundamental understanding of the invention, the description taken with the drawings making apparent to those skilled in the art how the several forms of the invention may be embodied in practice.

## BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

Fig. 1 is a cross-sectional view of a flat panel display device according to the present invention;  
Fig. 2 is an exploded view of the device of Fig. 1;  
Fig. 3 is a cross-sectional view of a modification of the device of Fig. 1;  
Fig. 4 is an exploded view of the device of Fig. 3, and  
Fig. 5 is an exploded view of another embodiment of a flat panel display device according to the present invention.

## DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Referring to Figs. 1 and 2, there is shown a flat panel display device 2 which includes a backplate 4, made of a suitable insulating material, and a transparent front face 6, usually made of glass. The backplate 4 and the front face are hermetically sealed so as to form a vacuum space thereinbetween. On the inside surface of backplate 4 there are affixed rows 8 and columns 10 of thin-film conductors separated by a thin layer of oxide thereby incorporating an array of, per se known, cold cathodes or electron-emitting junctions 9. Each cold cathode or junction is thus individually addressable and hence selectively actuatable when signals are applied to end terminals 12 and 14 of respectively both the rows 8 and the columns 10.

The array of cold cathodes may be directly formed on the backplate 4 as shown, or alternatively, may be formed on a separate plate which will eventually be affixed onto the backplate 4.

6. The device as claimed in claim 1, wherein said electron multiplier means comprises a collection of metal-doped packed glass particles.
7. The device as claimed in claim 1, wherein said array of cold cathodes is made of thin-film conductors separated by a thin layer of oxide.

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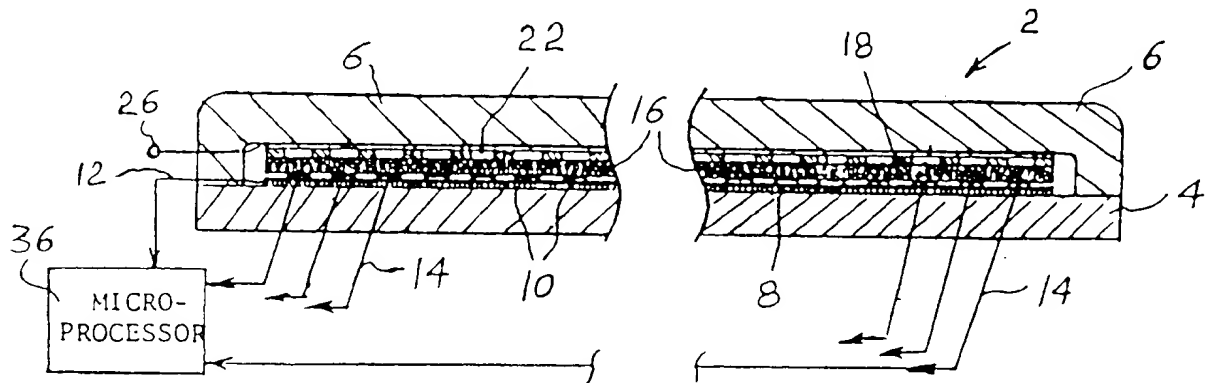


FIG. 1

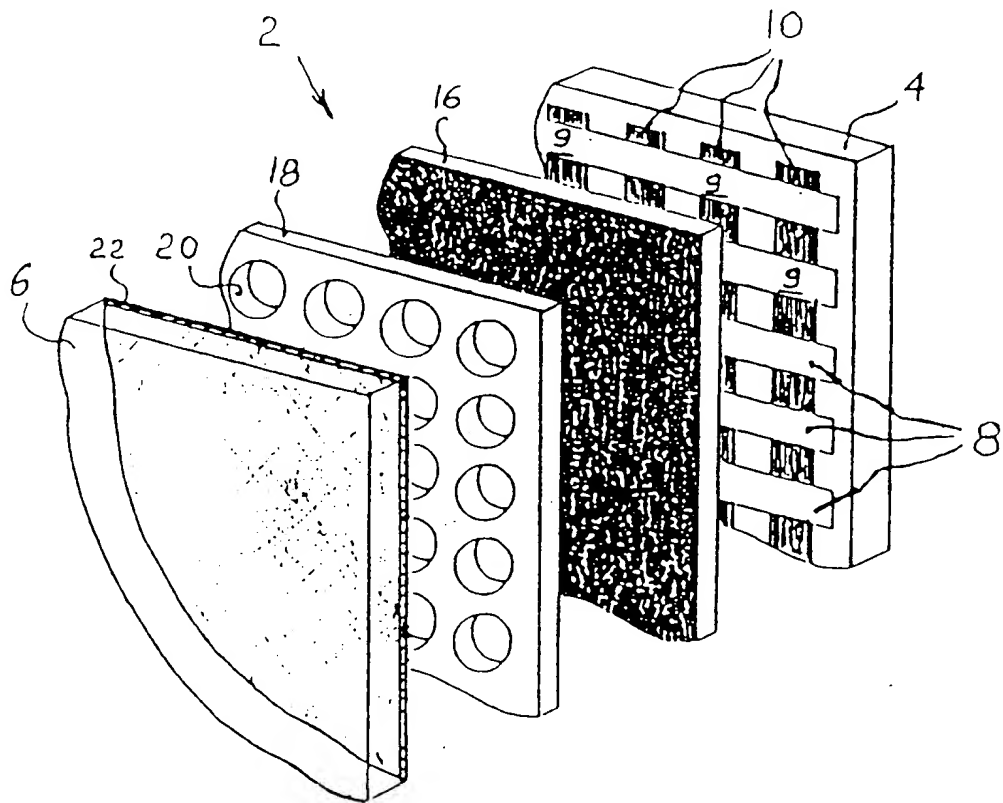


FIG. 2

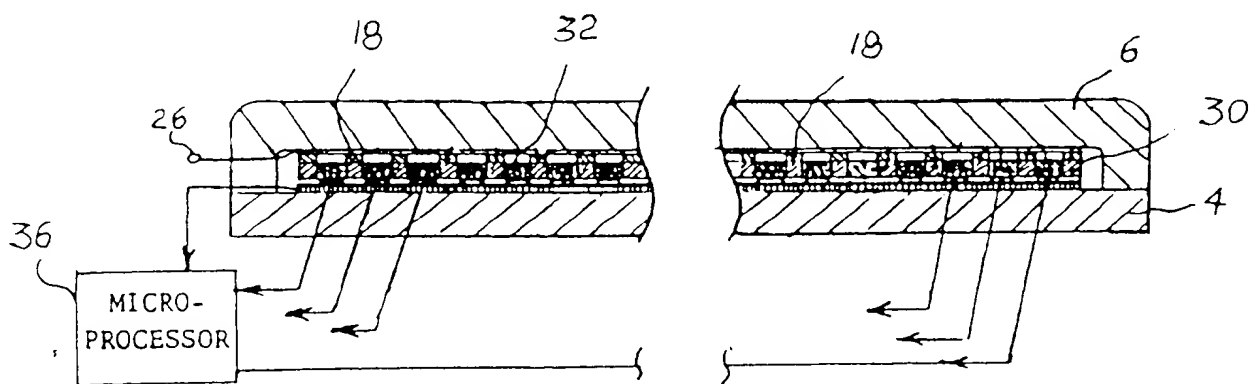


FIG. 3

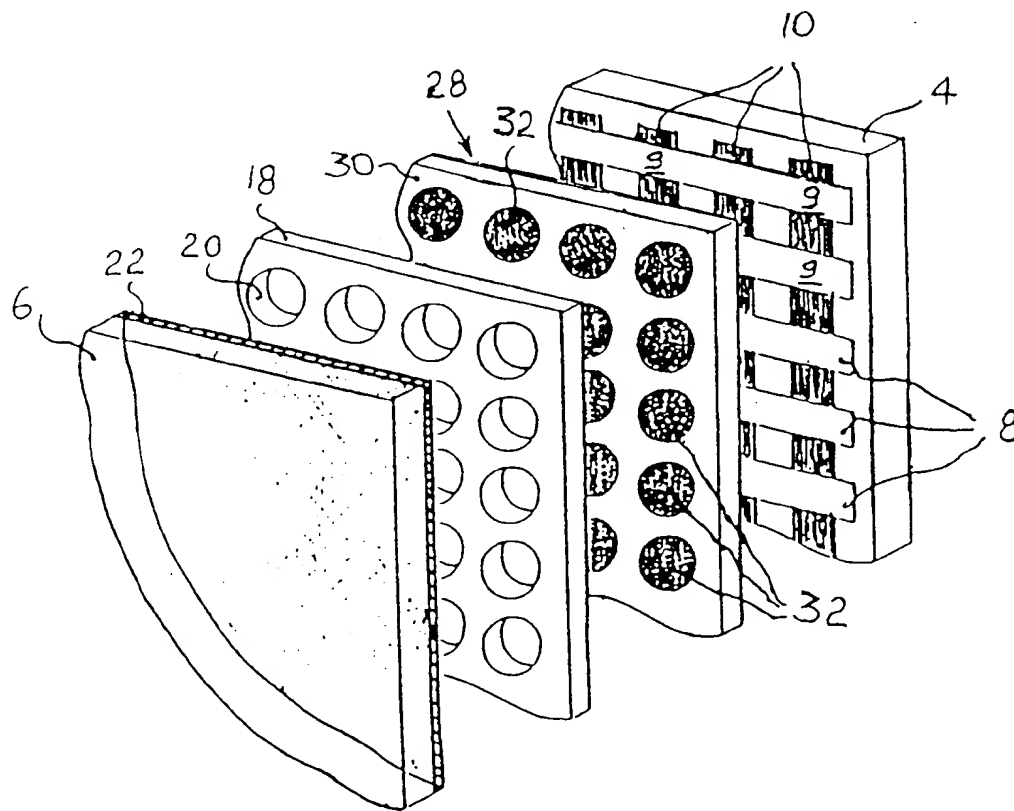


FIG. 4

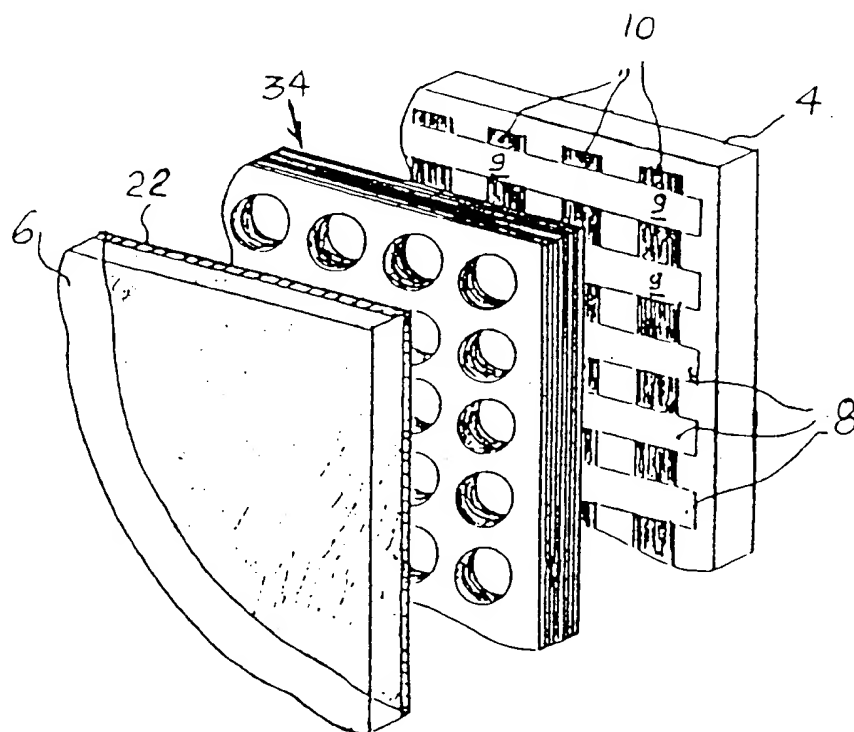


FIG. 5



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# EUROPEAN SEARCH REPORT

Application Number

EP 91 30 8478

## DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	US-A-4 577 133 (WILSON) * abstract; figures 1-3 * * column 3, line 16 - line 23 * * column 3, line 49 - column 4, line 4 * * column 4, line 68 - column 5, line 7 *	1, 4, 7	H01J31/12
Y	---	2, 6	
Y	EP-A-0 353 632 (YEDA RESEARCH AND DEVELOPMENT COMPANY, LTD.) * column 4, line 14 - line 30; figures * * column 5, line 7 - line 13 * * column 5, line 43 - line 58 *	6	
Y	---		
Y	GB-A-1 295 832 (MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.) * page 2, line 35 - line 68; figure 3 *	2	
A	---	6	
X	EP-A-0 107 217 (PHILIPS ELECTRONIC AND ASSOCIATED INDUSTRIES LIMITED) * abstract; figures 1,2 * * page 2, line 26 - line 33 * * page 4, line 35 - page 5, line 6 * * page 6, line 21 - line 26 *	1, 4	
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The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			H01J

Place of search THE HAGUE	Date of completion of the search 10 DECEMBER 1991	Examiner COLVIN G. G.
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application I : document cited for other reasons &amp; : member of the same patent family, corresponding document</p>		

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